



Atmospheric Deposition: Transport of Pollutants from Air to Water

Lisa D. Sabin

Southern California Coastal Water Research Project

California Non Point Source Conference

San Diego, CA

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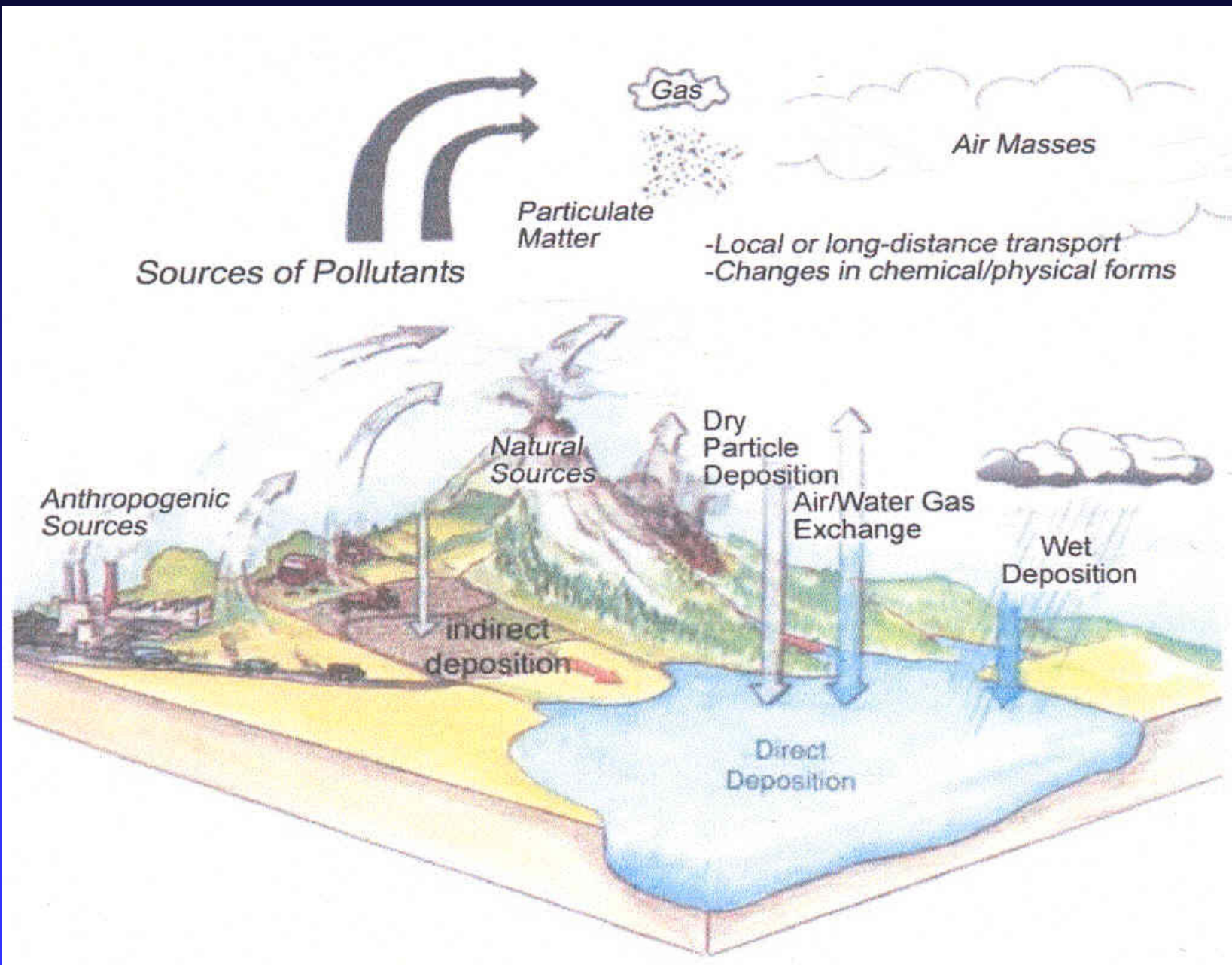
Why should we care about atmospheric deposition?

- Atmosphere is potentially large source of water pollution
 - ◆ Great Lakes, Chesapeake Bay (others)
 - ◆ Trace metals, organic compounds, nutrients
- Atmosphere is largely unmonitored source of water pollution in southern California
 - ◆ Air regulations not focused on ecosystem health
 - ◆ So Cal has some of worst air quality in the nation

Roadmap for Today

- What is atmospheric deposition?
- Is atmospheric deposition a large source to water?
- What are the atmospheric deposition rates in southern California?
- What is the relationship between atmospheric deposition and stormwater runoff?
- Is atmospheric deposition getting better or worse?

What is atmospheric deposition?



Is atmospheric deposition a large source to water?

- Trace metal loads in Santa Monica Bay
 - ◆ Airshed fate and transport model
 - ◆ SCAQMD MATES II data for model calibration
 - ◆ Independent measurements at UCLA for validation
- Atmospheric deposition rivals point sources
 - ◆ Indirect deposition to watershed is large contributor

What are atmospheric deposition rates in Southern California?

■ Methods:

- ◆ Focus on trace metals
- ◆ Measurement data using multiple techniques
- ◆ Sites in coastal areas of southern California
 - ◆ Los Angeles/Orange counties
 - ◆ Coastal sites along a north-south transect
- ◆ Variables
 - ◆ Wet vs. dry deposition
 - ◆ Urban vs. non-urban
 - ◆ Meteorology
 - ◆ Proximity to local sources

Instrumentation



Top
View



Sampling Sites

Santa Barbara

Oxnard

Malibu

Santa Monica Bay

Los Angeles Harbor

Upper Newport Bay

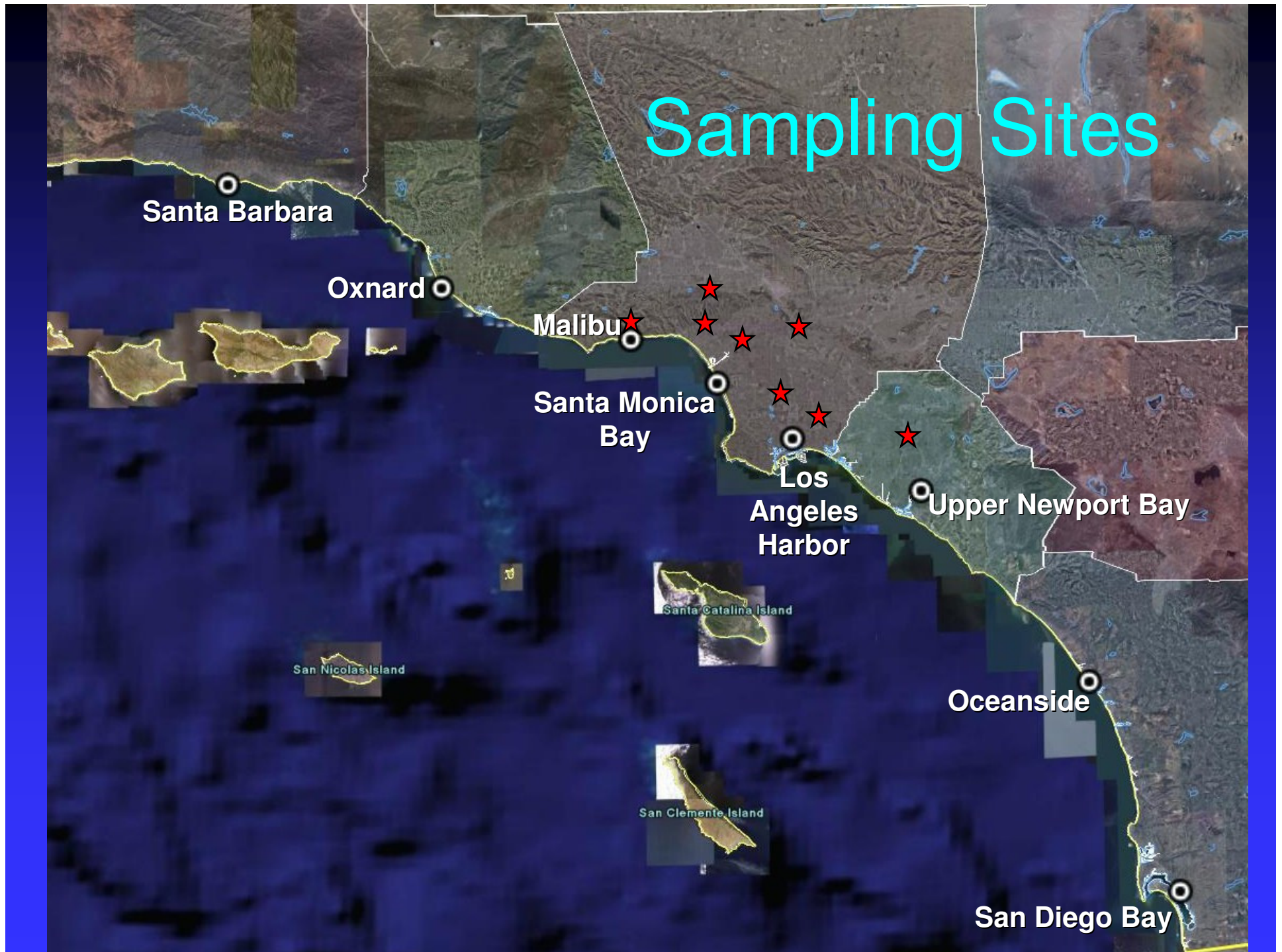
Oceanside

San Diego Bay

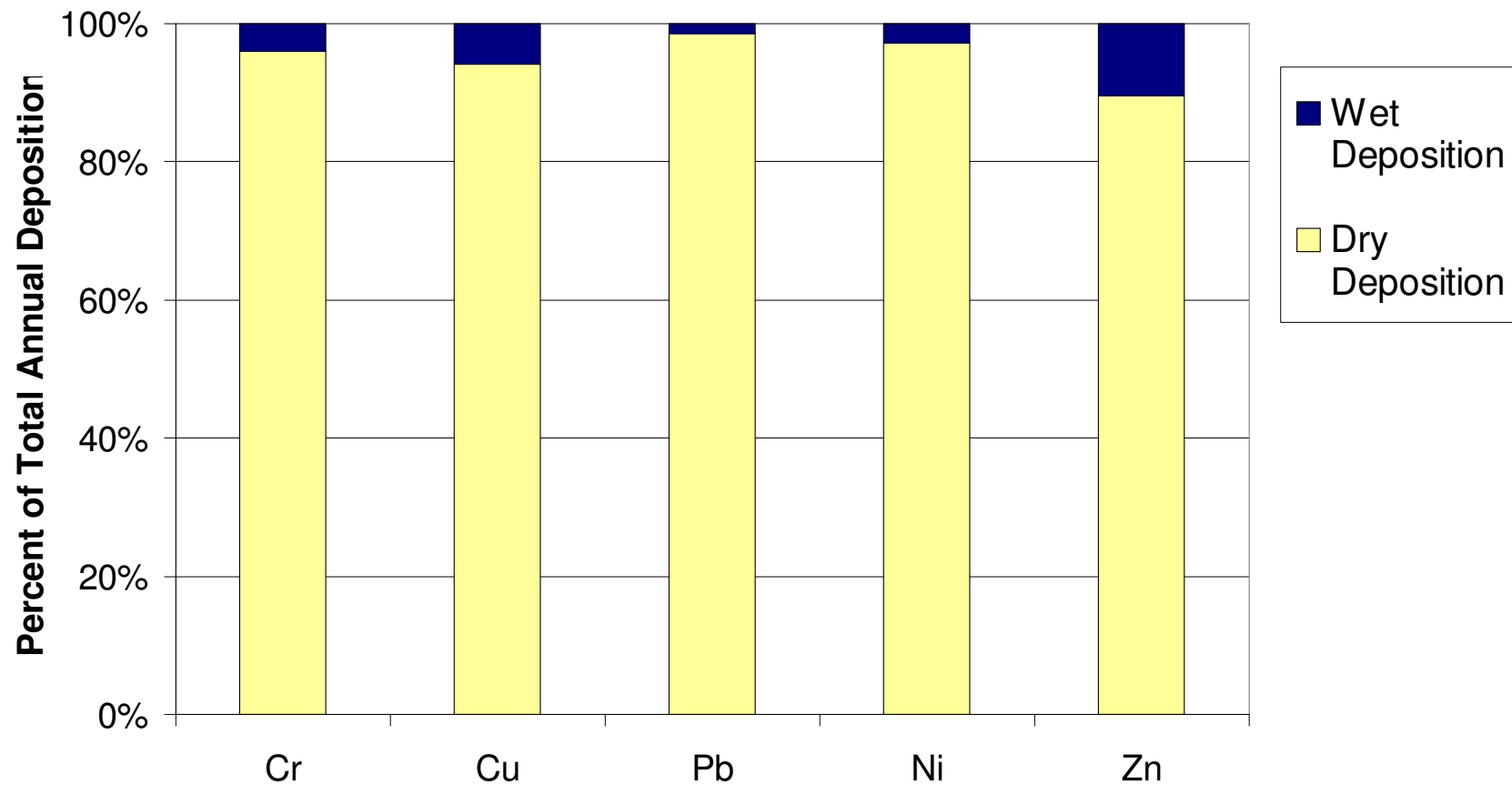
Santa Catalina Island

San Nicolas Island

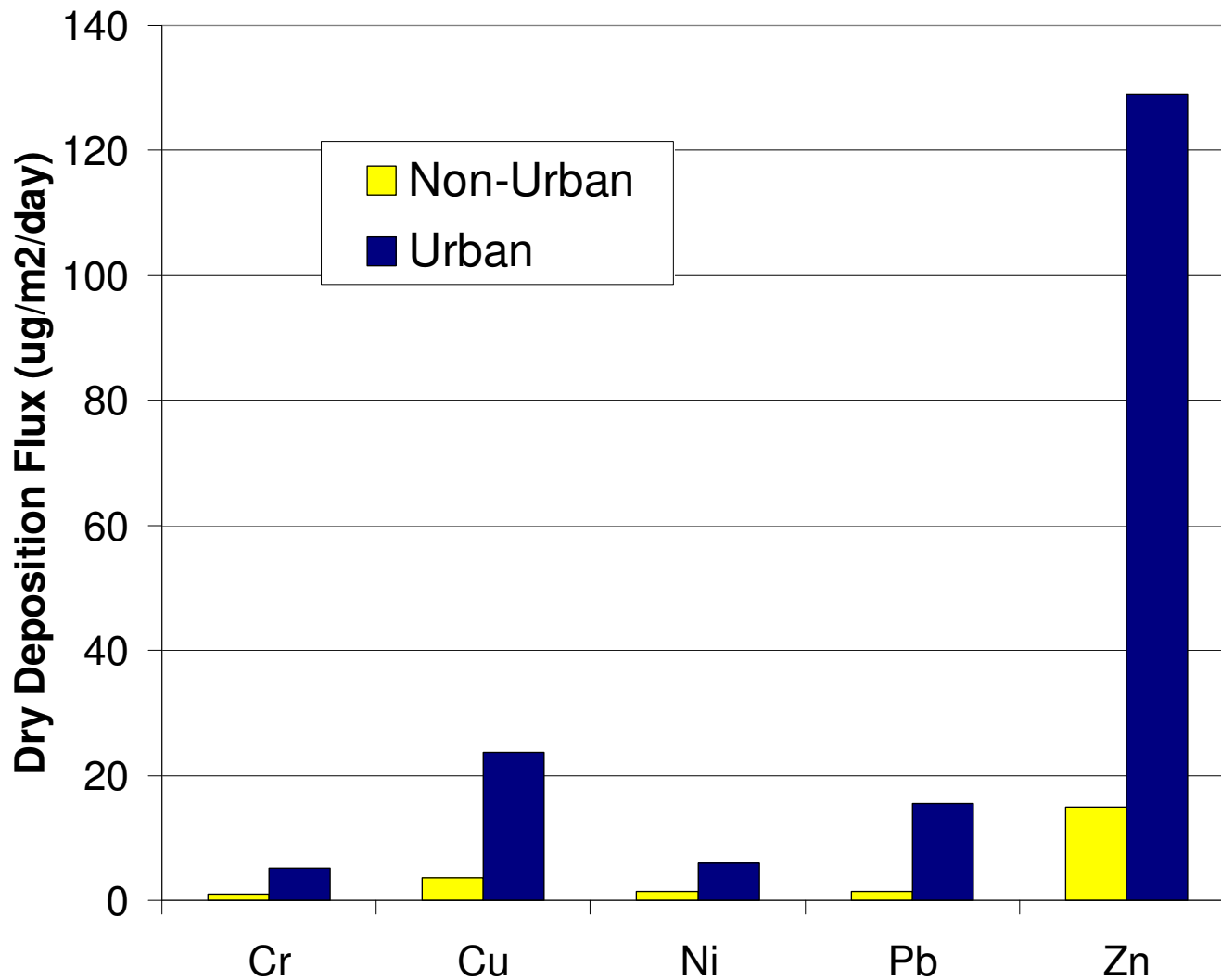
San Clemente Island



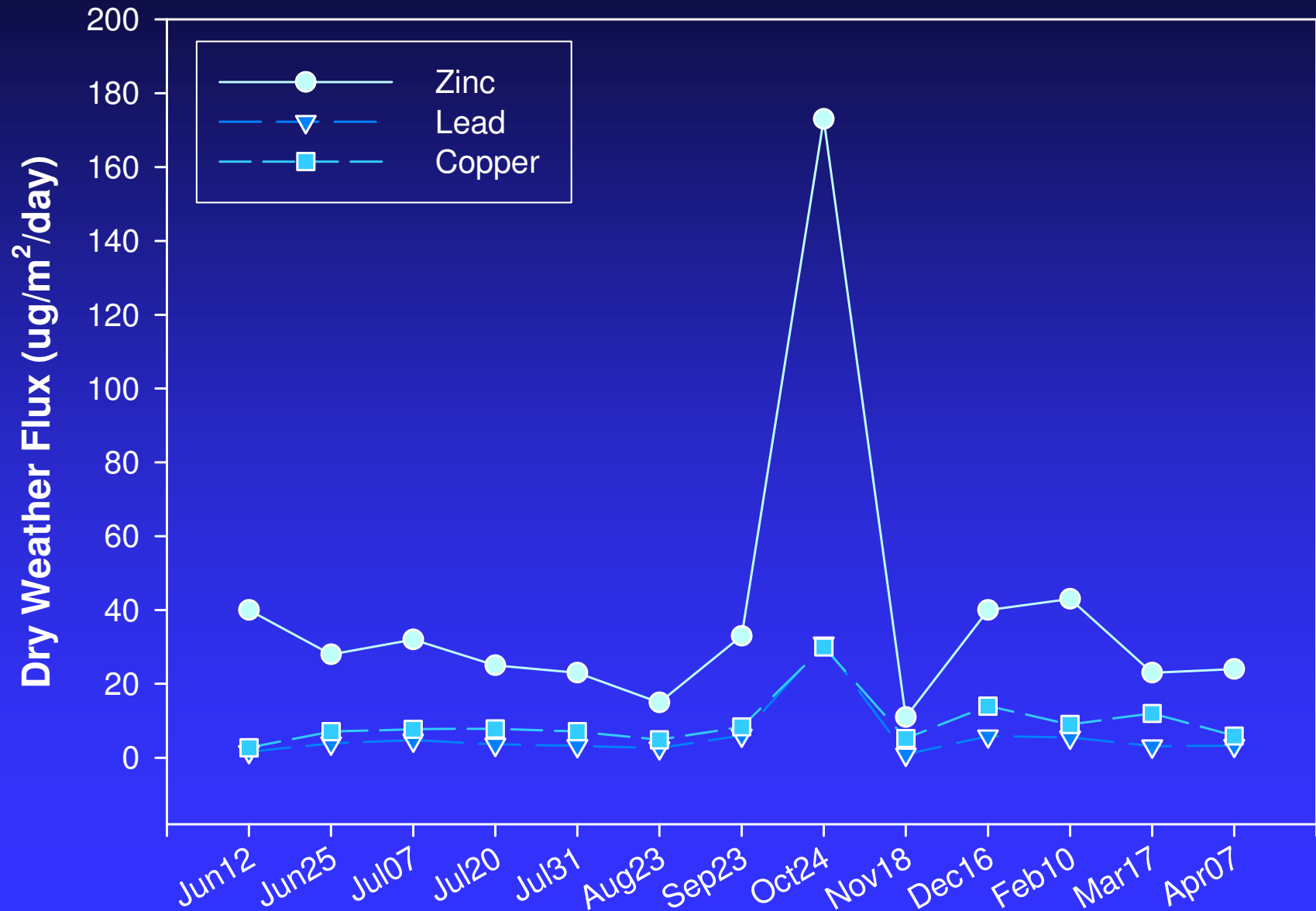
Annual Load: Wet vs. Dry Deposition



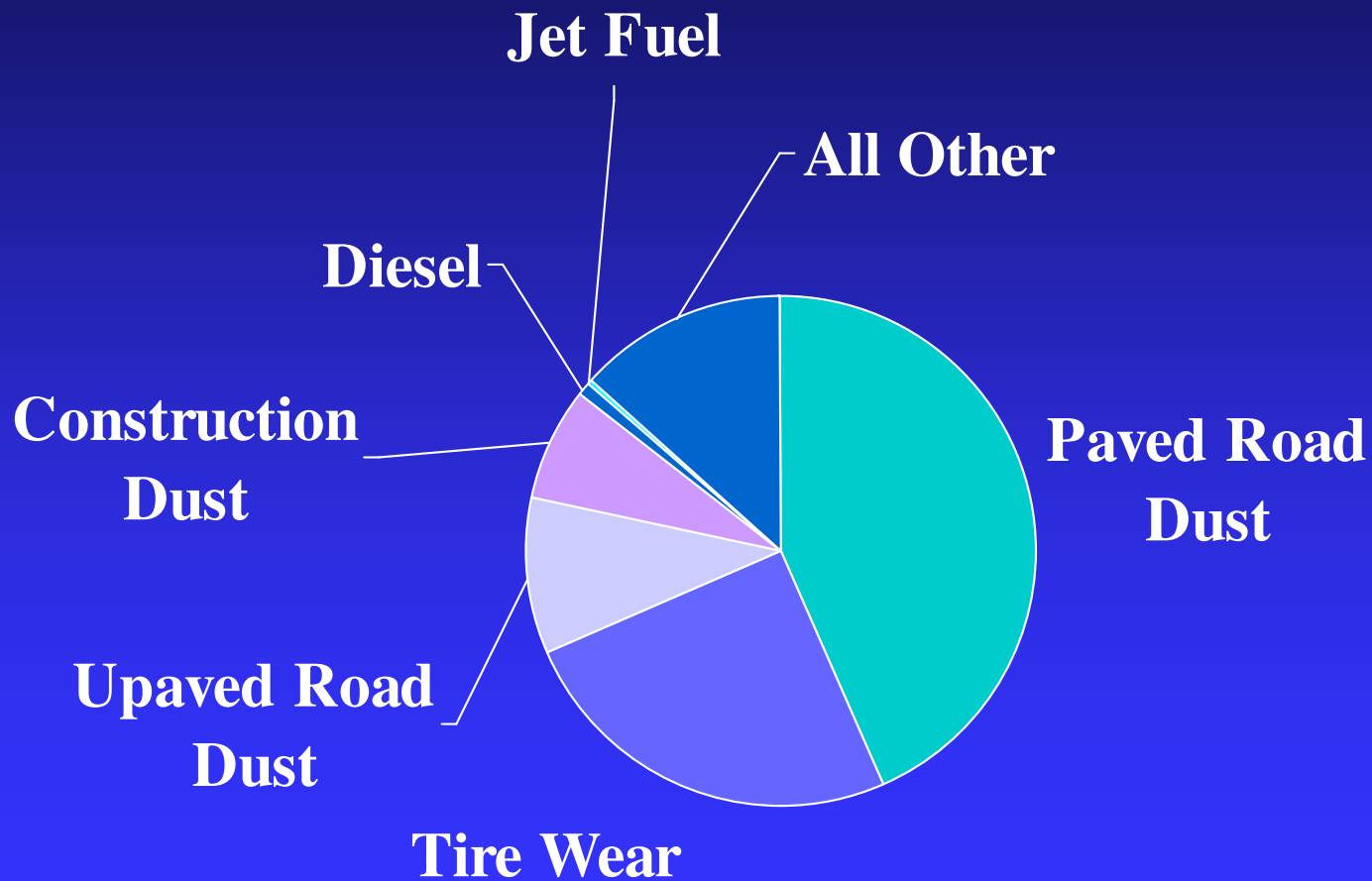
Urban vs. Non-urban



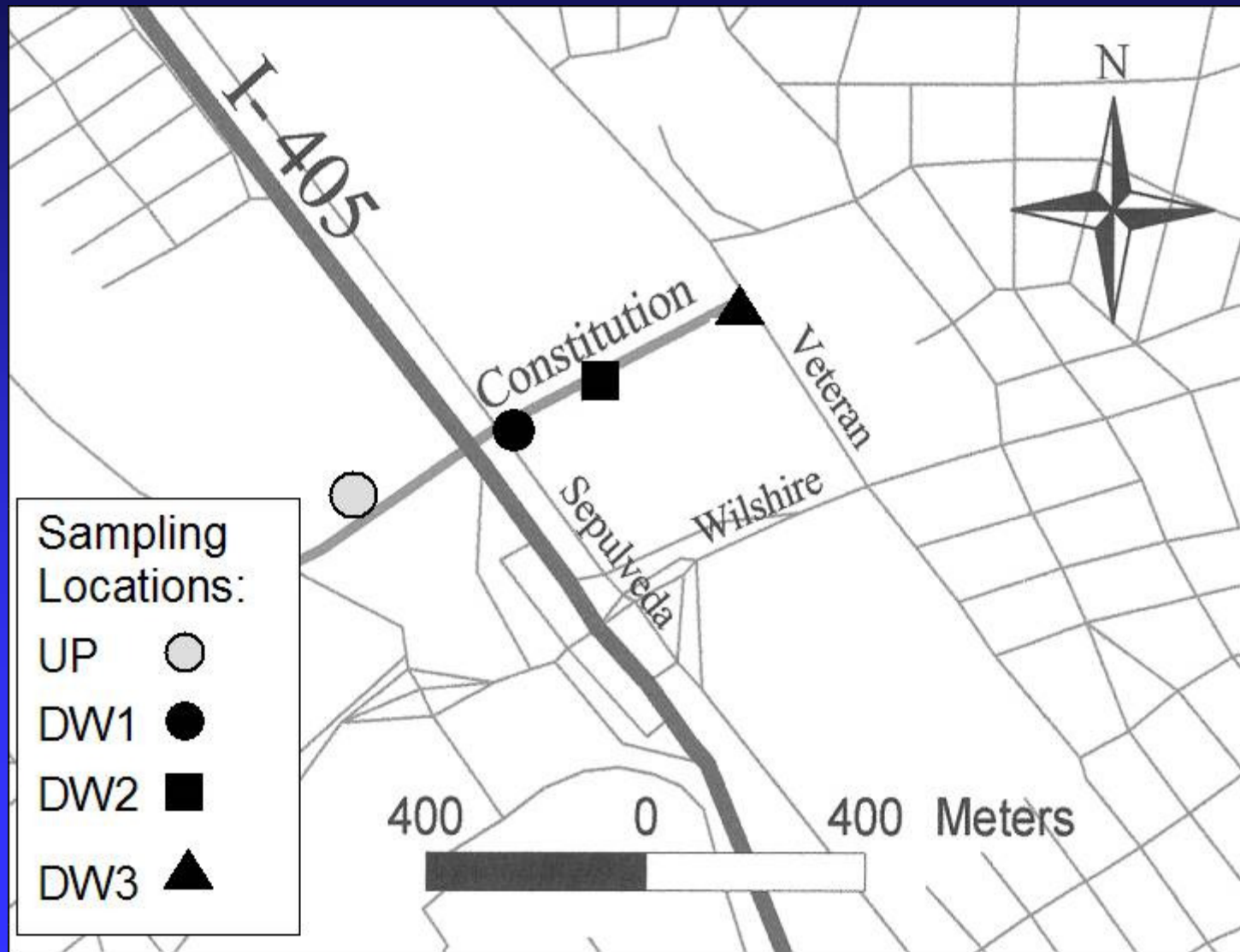
Dry Deposition Time Series



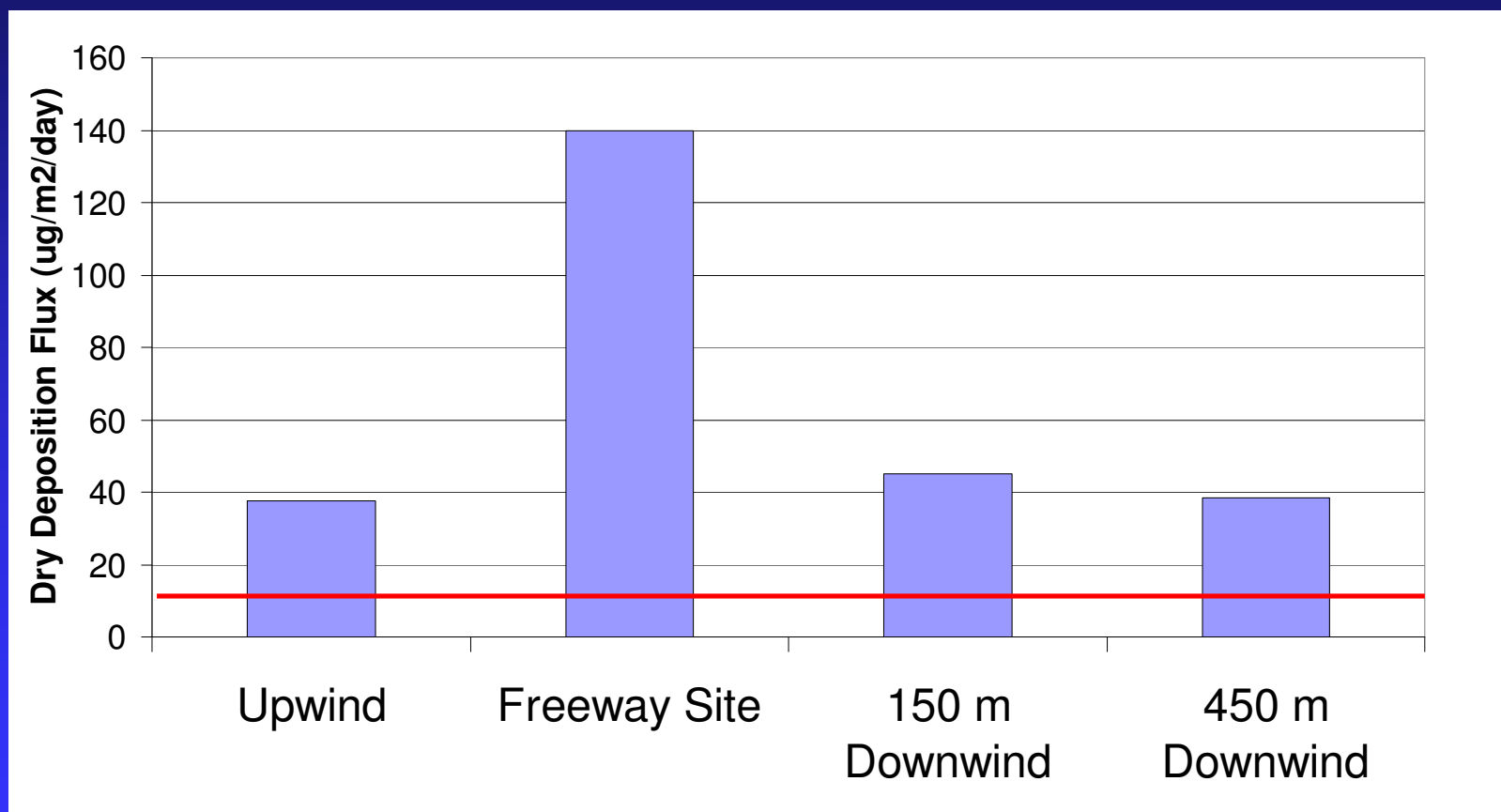
Los Angeles Basin-wide Zinc Emissions (1,069 mt/day)



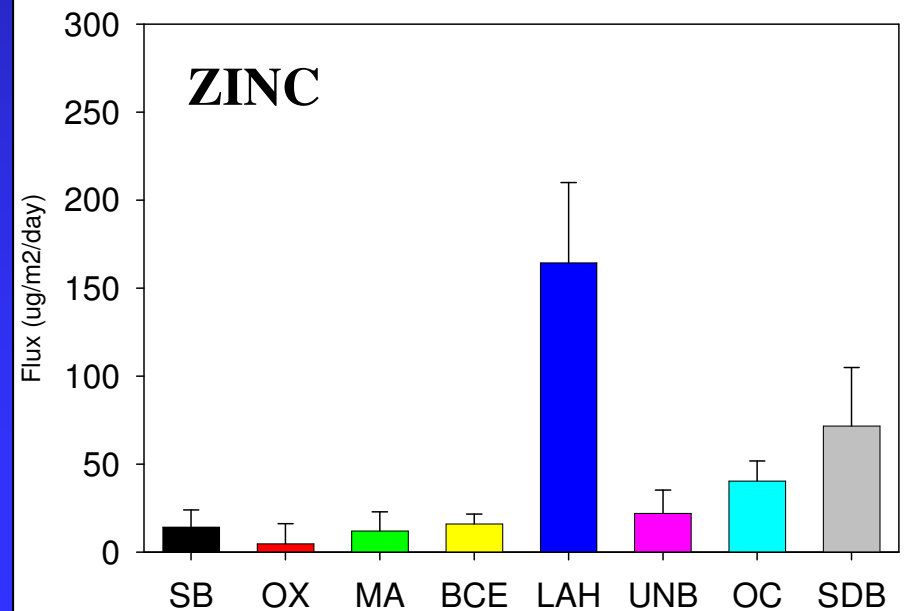
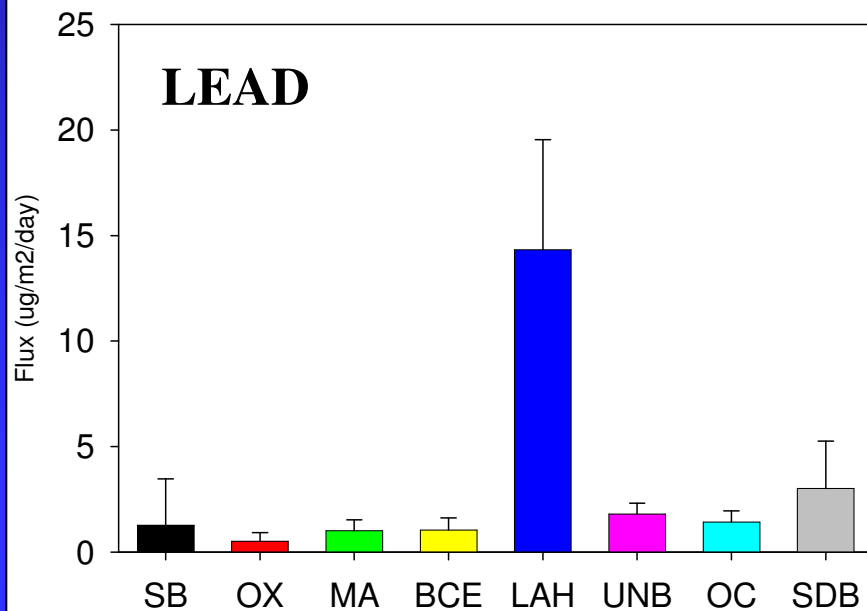
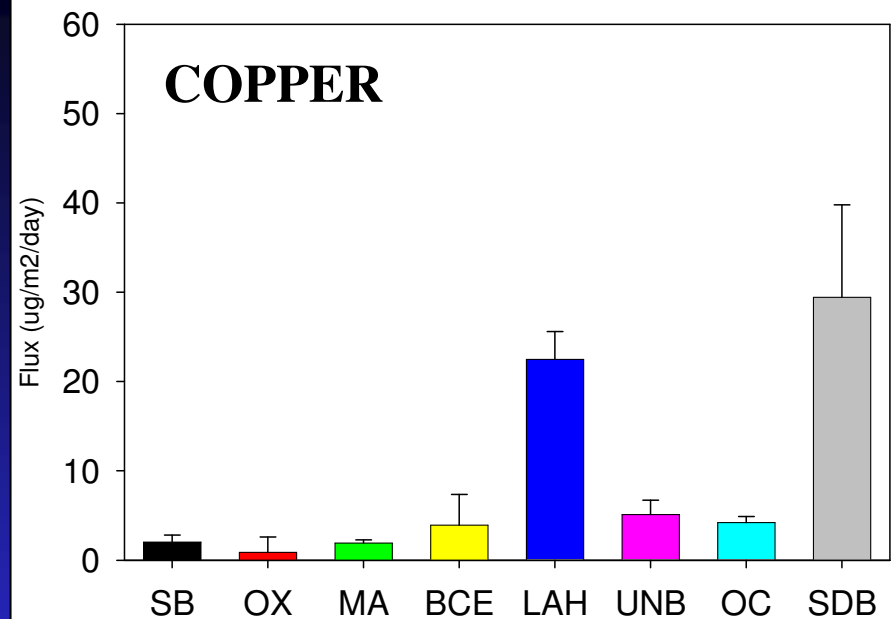
Deposition Near a Major Freeway



Zinc Dry Deposition Flux Near a Freeway in Los Angeles



Dry Deposition Rates along a Coastal Transect



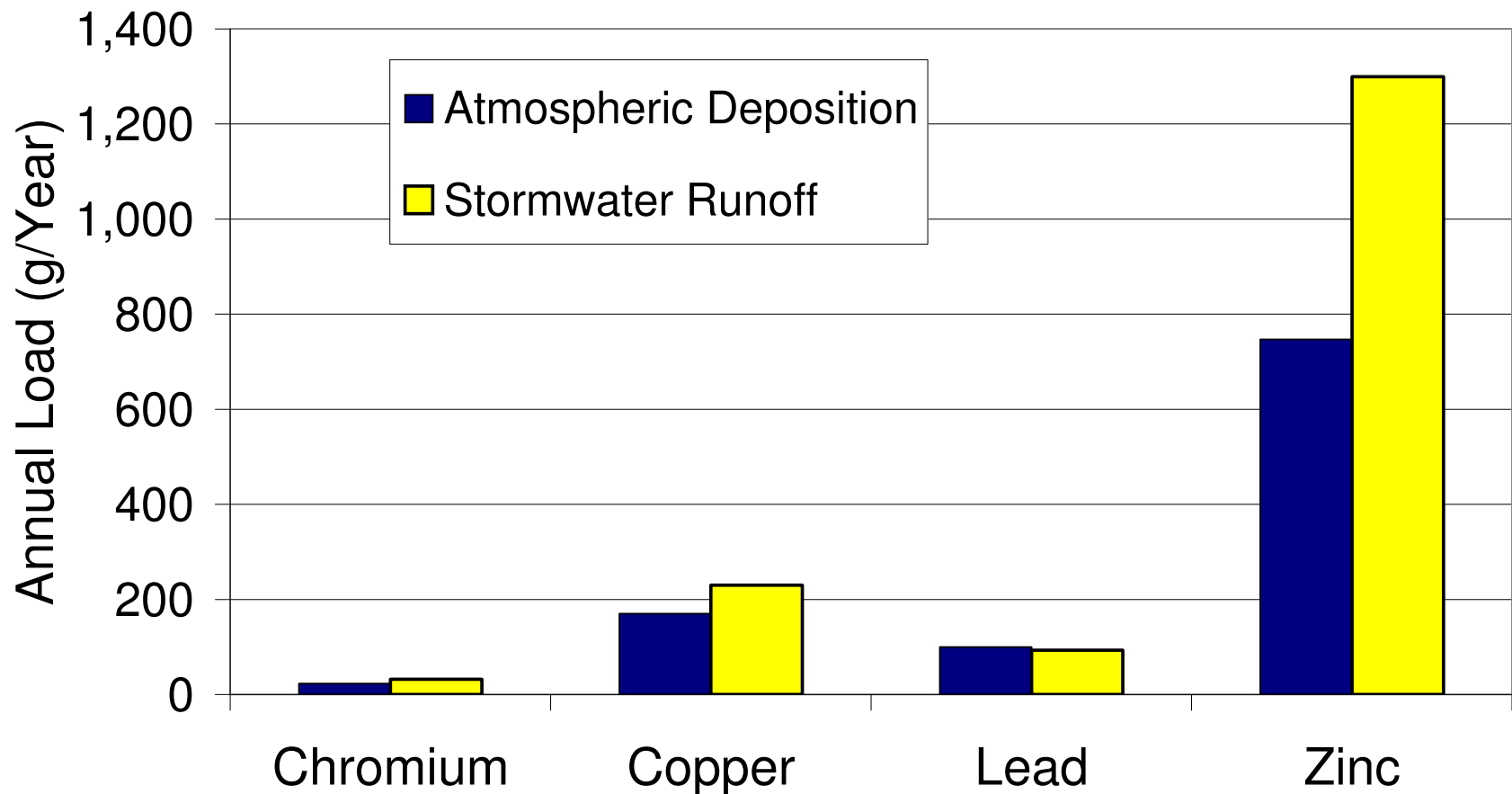
What is the relationship between atmospheric deposition and stormwater?

■ Methods:

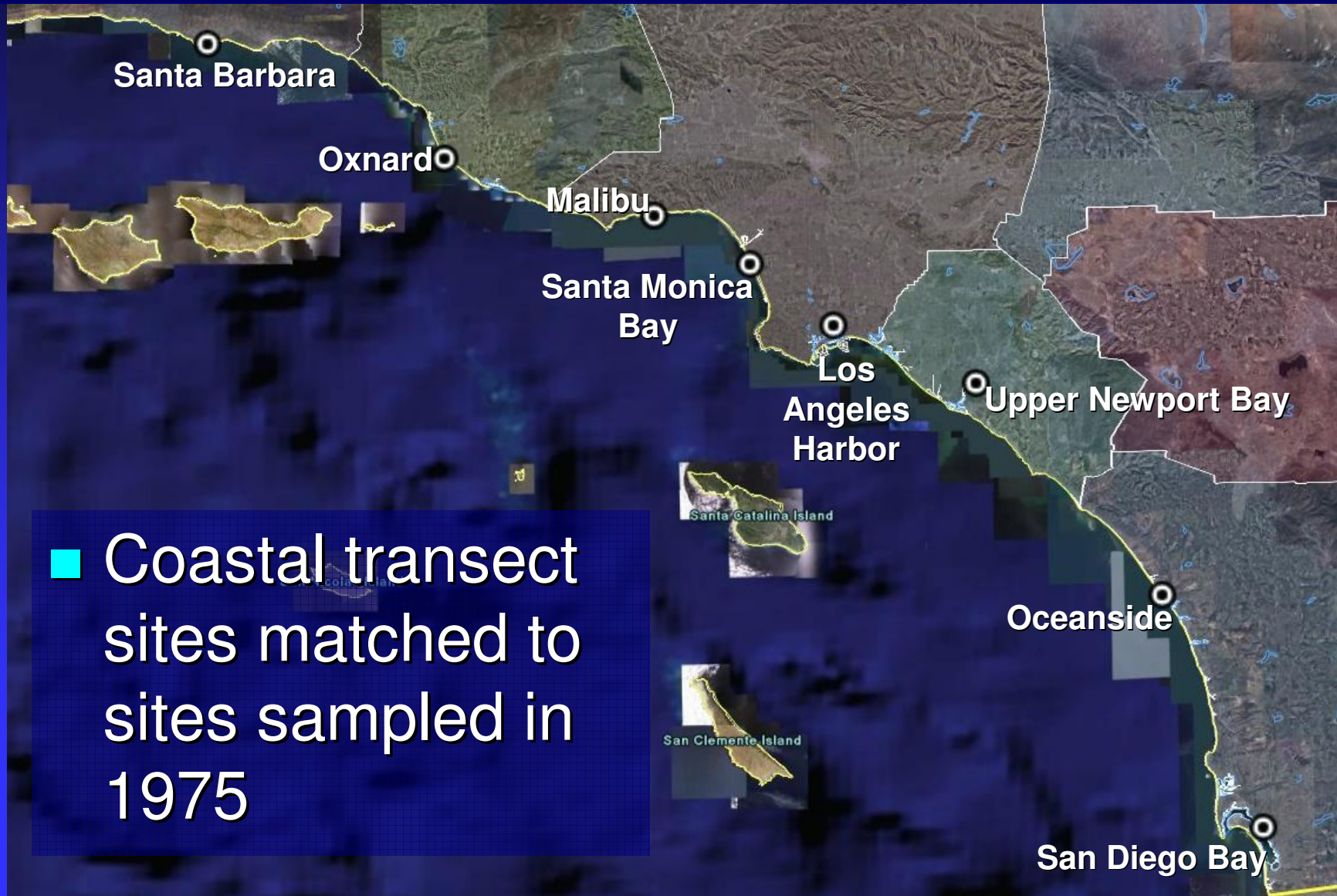
- ◆ Small, highly impervious urban catchment
 - ◆ Few sources of trace metals
- ◆ Starting at beginning of the dry season:
 - ◆ Monthly dry deposition measurements for one year
 - ◆ Wet deposition + stormwater collected for all major storms

- Atmospheric deposition comprised a large portion of stormwater load in the catchment

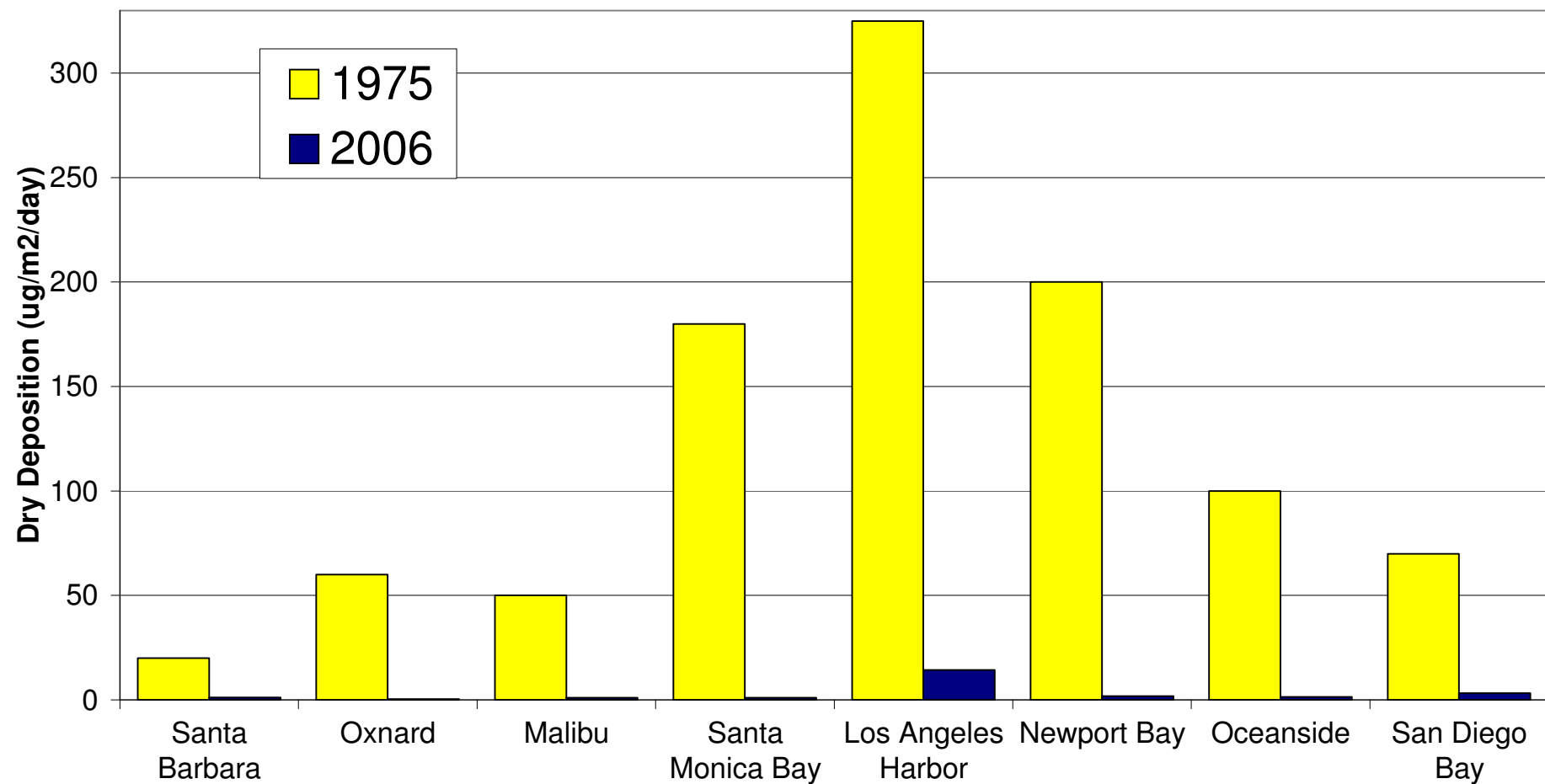
Atmospheric Deposition vs. Stormwater in a Small Urban Catchment



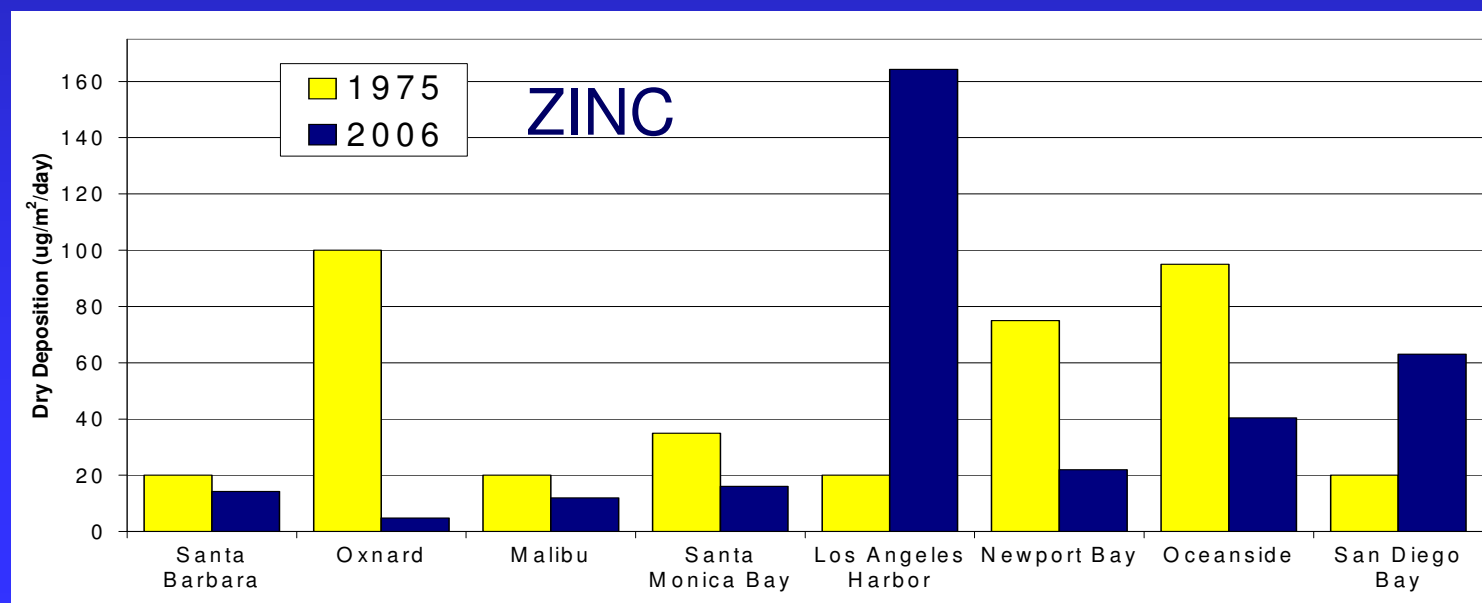
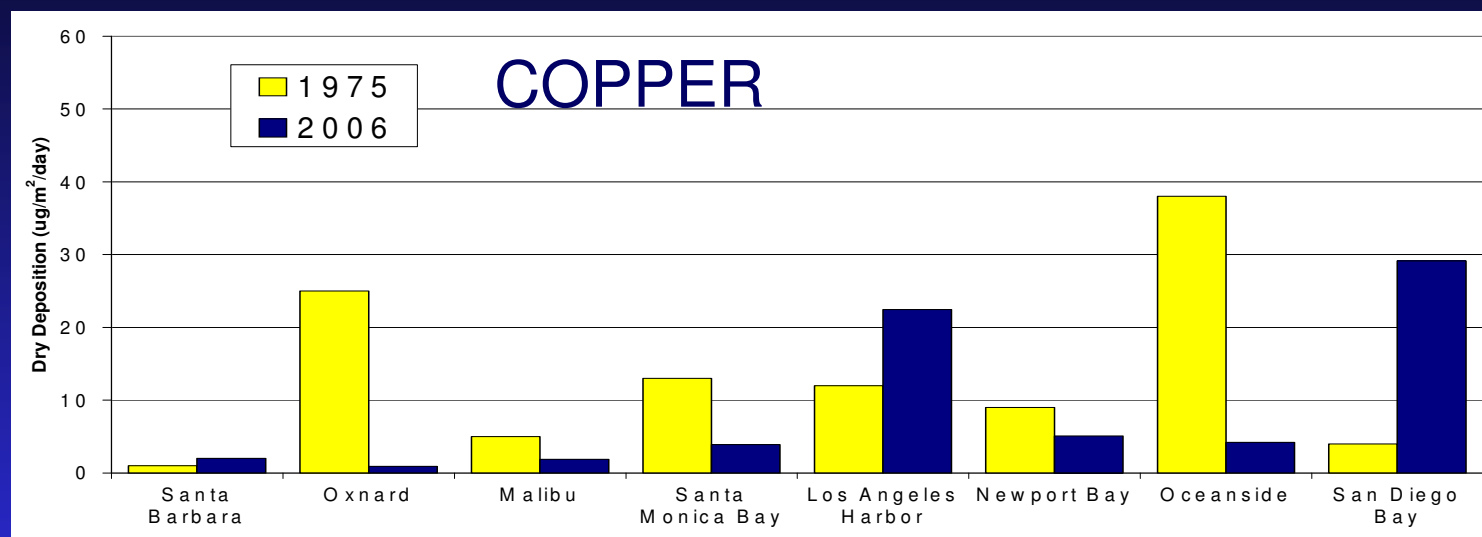
Is atmospheric deposition getting better or worse?



Lead Flux: 1975 vs. 2006



Copper and Zinc Flux: 1975 vs. 2006



Major Conclusions for Trace Metals

- Atmospheric deposition rivals point sources to local waterbodies
- Highest dry deposition rates associated with:
 - ◆ Urban areas
 - ◆ Roadways - hotspots for deposition
- Indirect dry deposition can comprise the majority of the load in stormwater runoff in urban watersheds
- Cu and Zn dry deposition rates have increased since 1970's at urban sites

Future Atmospheric Deposition Research: Nutrients

- Nutrients can trigger plankton blooms
- Atmospheric contribution of nutrients to receiving waters in other regions is large
 - ◆ East Coast: 20 to 40% of new nitrogen inputs to coastal waters are atmospheric
- Atmospheric contribution in southern California is largely unknown
 - ◆ Eutrophication impacts are widespread
 - ◆ Numeric nutrient criteria are coming

Acknowledgements

■ Funding

- ◆ Santa Monica Bay Restoration Project
- ◆ US EPA Great Waters Program
- ◆ Los Angeles and San Diego Regional Water Quality Control Boards
- ◆ Los Angeles County Dept of Public Works
- ◆ City of Los Angeles
- ◆ SCCWRP

■ Collaborators

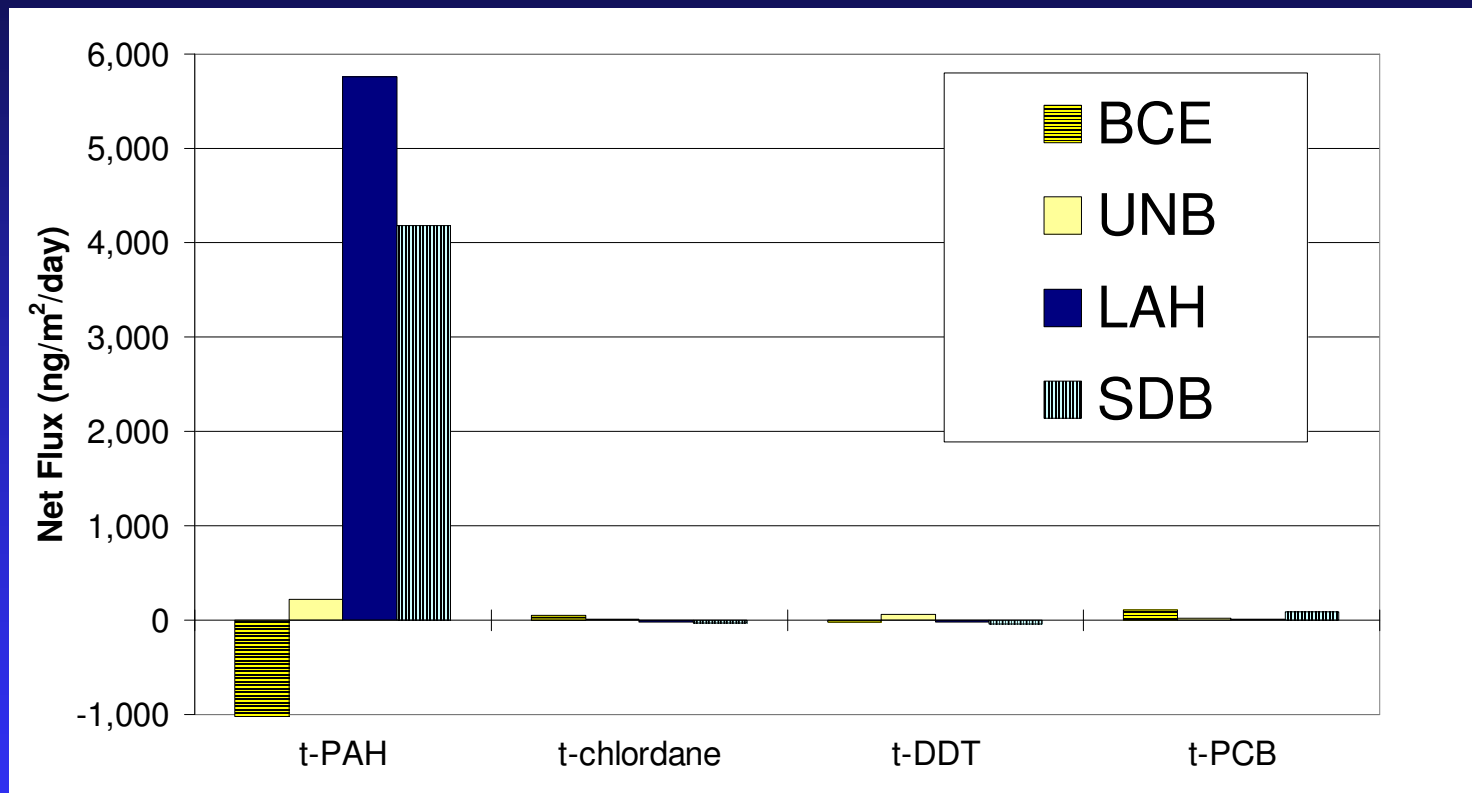
- ◆ UCLA Institute of the Environment

For more information:

- www.sccwrp.org
- lisas@sccwrp.org
- Tel: (714) 755-3221



Net Air-Water Exchange for HOCs



Positive Net Flux = Water is source to air
Negative Net Flux = Air is source to water

Annual Load from Direct Dry Atmospheric Deposition to Los Angeles Harbor Compared with Other Sources

	Dry Atmospheric Deposition kg/yr	Terminal Island POTW*	Industrial Discharges kg/yr	Dominguez Channel**	Los Angeles River**
Cu	350	83	2	580	1,400
Pb	220	nd	1	96	880
Ni	85	nd	5	120	700
Zn	2,500	605	63	6,300	5,600

*Mass emissions from 2000 (Steinberger and Schiff, 2002)

**LACDPW 2000-2001 Annual Monitoring Reports - Wet Weather Only

Annual Load to Santa Monica Bay from Different Sources (mt/year)

	Direct Deposition to SMB	Indirect Deposition to SMB watershed	Runoff ¹	Hyperion ²	Industrial + Power Plants ²
Cr	0.14	0.64	0.04	0.6	0.16
Cu	0.92	4.2	1	16	0.04
Pb	0.67	3.53	1.1	0	0.02
Ni	0.2	0.59	0	5.1	0.14
Zn	3.21	14.43	10.2	21	2.56

¹Los Angeles County Department of Public Works Wet Season Report (1996)

²Southern California Coastal Water Research Project Annual Report (1996)